

REMARKS

In the Final Action the Office has removed the rejections under 35 U.S.C. § 112 and 35 U.S.C. § 103(a) that were made in the first Office Action dated July 29, 2008.

The the Final Action the Office is again rejecting claims 1-5, 8-10, 12-17 and 22 as being unpatentable under 35 U.S.C. § 103(a) and is relying on the same primary references cited in the first Action (i.e., JP 2003-007295 ("JP '295") and JP 01-029913 ("JP '913")) for the disclosure of a rechargeable lithium battery in which the negative electrode comprises a noncrystalline (amorphous) silicon thin film which may contain cobalt or iron. The Office is relying on each of Ebner et al., U.S. Patent No. 4,853,304 ("Ebner") and JP-07-249431 ("JP '431") as teaching the addition of carbon dioxide to the non-aqueous batteries of JP '295 and JP '913 to improve the cycling efficiency and as teaching a roughness of the current collector of 0.1 micron to improve the adhesion of the thin film on the current collector.

Applicants respectfully submit that a person of ordinary skill in the art could not have reasonably predicted, from the cited references, the effects of adding carbon dioxide to a rechargeable lithium battery including a negative electrode made by depositing a noncrystalline thin film composed entirely or mainly of silicon

on a current collector as in the present invention and that, therefore, the references are insufficient to support prima facie obviousness of the rejected claims. Moreover, notwithstanding the insufficiencies of the references to support prima facie obviousness of the rejected claims, the effects of adding carbon dioxide to the nonaqueous electrolyte of the battery of the present invention are unexpected.

As described in paragraphs [0054] - [0064] of the present specification, dissolving of carbon dioxide in the nonaqueous electrolyte of the battery of the present invention retards oxidation of an Si thin film and increase in porosity of the Si thin film, which result in improved cycle characteristics and suppression of increase in thickness of the active material after charges and discharges.

JP '295 and JP '913 disclose nothing concerning the addition of carbon dioxide to the electrolyte of the batteries disclosed therein.

In Ebner, lithium metal is used as a negative electrode material (Col. 2, line 24). Ebner discloses that "it is believed that CO₂ acts as a precursor to form an ionically conductive, protective film on the surface to the lithium metal which prevents freshly deposited lithium from undergoing parasitic side reactions

with the electrolyte solution. It is further proposed that CO₂ could also be altering the morphology of the plated lithium, making it less dendritic in nature." (Col. 4, lines 62 - 68). However, in the case of a silicon thin film as used as an anode in the present invention, deposited lithium and plated lithium are not produced on the negative electrode during charge and discharge cycles. Thus, nothing in Ebner provides any teachings to enable the art-skilled person to predict the results of adding carbon dioxide to a battery, as in the JP '295 and JP '913 primary references, in which the anode comprises a noncrystalline (amorphous) silicon thin film.

With respect to JP '431, the purpose and effect of dissolving carbon dioxide in the electrolyte of the battery is to improve the safety of the battery even in the case where a safety valve mechanism is operated in the high temperature environment to blow out the nonaqueous electrolyte (English abstract). JP '431 discloses carbon materials, chalcogen compounds, aluminum, aluminum alloys, magnesium alloys, lithium metal, and lithium alloys as a negative active material (paragraphs [0019] - [0023]). However, JP '431 does not disclose silicon as a negative active material. The effect of dissolving carbon dioxide in JP '431 is obtained by releasing the carbon dioxide having a snuffing action from the nonaqueous electrolyte at the high temperature. JP '431 discloses

nothing concerning the effect of the carbon dioxide on the cycling efficiency of the battery. Therefore, like Ebner, nothing in JP '431 provides any teachings to enable the art-skilled person to predict the results of adding carbon dioxide to a battery, as in the JP '295 and JP '913 primary references, in which the anode comprises a noncrystalline (amorphous) silicon thin film.

For the above reasons, the combination of either JP '295 or JP '913, with either Ebner or JP '431, is insufficient to support prima facie obviousness under 35 U.S.C. § 103(a) of the claims of the application rejected over these references.

Moreover, notwithstanding the insufficiencies of the references to support prima facie obviousness, the effects of the addition of carbon dioxide to the electrolyte of the battery of the present invention, are unexpected.

As noted above, dissolving of carbon dioxide in the nonaqueous electrolyte of the battery of the present invention retards oxidation of an Si thin film and increase in porosity of the Si thin film, which result in improved cycle characteristics and suppression of increase in thickness of the active material after charges and discharges.

On the other hand, as shown by the data of the "REFERENCE EXPERIMENT" (paragraphs [0068] - [0081] of the present

specification), the effects of the present invention are not obtained when using a carbon material as negative electrode material. In the "REFERENCE EXPERIMENT", a carbon material is used as negative electrode material. Battery C1 uses a nonaqueous electrolyte in which CO₂ is dissolved, while battery C2 uses the same nonaqueous electrolyte in which CO₂ is not dissolved. As seen from the comparison between the results of batteries C1 and C2 shown in Table 4, the effects of the present invention are not obtained when using a carbon material as negative electrode material.

The effects illustrated by the data of the REFERENCE EXPERIMENT of dissolving CO₂ in the nonaqueous electrolyte of the rechargeable lithium battery of the present invention in which the negative electrode is made by depositing a noncrystalline thin film composed entirely or mainly of silicon on a current collector cannot be expected from the teachings of the prior art for the reasons explained above. The unexpected effects of the present invention support the non-obviousness of the rechargeable lithium battery of the present invention.

Removal of the 35 U.S.C. § 103(a) rejections of claims 1-5, 8-10, 12-17 and 22 is in order and is respectfully requested.

The rejections of claims 6, 7 and 18-21 depend on the propriety of the rejections of the claims on which these claims depend. Since the base claims have been shown to be patentable, the claims dependent thereon are prima facie patentable. Removal of the rejections of claims 6, 7 and 18-21 is also in order and is also respectfully requested.

The foregoing is believed to be a complete and proper response to the Office Action dated January 26, 2009.

In the event that this paper is not considered to be timely filed, applicants hereby petition for an appropriate extension of time. The fee for any such extension may be charged to our Deposit Account No. 111833.

In the event any additional fees are required, please also charge our Deposit Account No. 111833.

Respectfully submitted,

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